Message

From: d'Almeida, Carolyn K. [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=9EC4401AFA1846DD93D52A0DDA973581-CDALMEID]
Sent: 4/21/2015 6:55:39 PM
To: Wayne Miller [Miller.Wayne@azdeq.gov]
CC: Davis, Eva [Davis.Eva@epa.gov]; steve [steve@uxopro.com]
Subject: RE: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Thanks Wayne; I forwarded to Eva for her input.

My understanding of the situation is that prior to startup, the design report / TEE report provided estimates of NAPL remaining as follows:

Hydrostratigraphic unit	NAPL Remaining w/in SEE treatment zone (gallons)	NAPL Remaining outside SEE treatment zone (gallons)
CZ / UWBZ	150,000 - 300,000	80,000 – 360,000
LSZ	240,000 - 940,000	30,000 - 270,000
total	430,000 – 1,050,000	140,000 – 530,000

Sossaman Road is a barrier for steam implementation, but was never a barrier to NAPL migration, so that the fact that there is NAPL there now is no surprise, and not necessarily an indication of NAPL spreading but just as likely was there prior to steam. The fact that it is now flowing into wells where it can be extracted I think is a good thing. Installing more extraction wells to remove NAPL during SEE might be beneficial if there was evidence that they would remove a lot of product, however, of the 16 perimeter wells they have only 11 and 37 seem to be producing any NAPL for passive capture. If there was significant off site migration I think you would seem more NAPL migrating into more wells. To do more active pumping at the perimeter for containment would require them having to tie in to the SEE treatment system, with pipelines crossing Sossaman Road. If they were going to do that it should have been dealt with at the design phase; it's a little too late to add on to treatment system now; I don't know if they have the capacity to handle more water from additional wells. It would not be a simple matter to change their approach at this time. They will have to perform NAPL reconnaissance anyway after they finish to determine the best locations for EBR wells. I don't know what the benefit to starting reconnaissance while the system is operating would be.

Carolyn

From: Wayne Miller [mailto:Miller.Wayne@azdeq.gov]
Sent: Tuesday, April 21, 2015 8:35 AM
To: d'Almeida, Carolyn K.
Cc: steve
Subject: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Carolyn – The following is presented to obtain U.S. EPA input.

ADEQ management is concerned that contaminant is not contained. ADEQ management instructed staff and subcontractor review to focus on containment compliance (but not to exclude other issues). My specific directive is to accelerate the downgradient remediation well installation.

What follows is a DRAFT communication, with ADEQ Contractor comments to be communicated to USAFCEC within the week:

Assessment revealed the following:

General Comments:

ADEQ provided comments to the Air Force by email on 24 February 2015 questioning whether containment of LNAPL and dissolved phase constituents has been achieved during operation of the Steam Enhanced Extraction (SEE) remediation system. The Air Force (AF) responded to the ADEQ comments on 9 March 2015. The responses did not sufficiently address ADEQ's concerns and ADEQ continues to question hydraulic containment based on the data provided in summary format in the SEE system weekly progress reports.

In its March 9 response, AF cites net surplus extraction and the implementation of operation and monitoring approaches described in the RD/RAWP to substantiate hydraulic containment. As described below, these statements alone are inadequate to suggest containment and additional discussion is requested.

The hydraulic containment approach is articulated in the RD/RAWP on p. 4-6:

> *There is a net extraction of groundwater from ST012 during SEE to provide hydraulic containment and groundwater monitoring outside the limits of treatment to verify containment. Injection strategies will be refined during the RD/RA phase to address potential LNAPL migration. Where injection wells bound LNAPL, injections will occur with an outside in approach. Where LNAPL may exist at the perimeter of the treatment zone, initial extraction is anticipated. Monitoring of temperature within and at the perimeter of SEE, groundwater elevations and LNAPL accumulation outside the TTZ, and perimeter groundwater benzene concentrations will be used to demonstrate containment.*

Actual operations have deviated significantly from the operating conditions described in the RD/RAWP (e.g., the groundwater extraction rate has operated well below planned capacities throughout operations while steam injection has often occurred at or near maximum rates). As a result, the relationship between the observed responses in perimeter monitoring wells, the anticipated responses described in the RD/RAWP, and the effects on hydraulic containment should be documented for each zone and for each of the monitored parameters: groundwater elevations, temperatures, LNAPL measurements, and dissolved benzene concentrations.

Comments on each of these parameters follow.

1. Net Surplus Extraction

The ratio of mass extraction to mass injection has remained low (~1.5 or less) compared to the work plan (~2.3) and extraction was halted for a two-week period in late December-early January while steam injection continued. It is not evident that this lower ratio of mass rates was evaluated for

hydraulic containment in the RD/RAWP. The ratio of mass extraction to mass injection at peak flows is described in the RD/RAWP as follows (p. 3-9):

> *The anticipated overall peak liquid extraction rate from the MPE wells is approximately 2.3 times the expected peak steam liquid injection rate.*

In addition, net surplus extraction on a mass basis is insufficient to demonstrate hydraulic containment. As stated in the RD/RAWP, Appendix D, p 19:

> *Numerical water and energy balance calculations were conducted as part of the design effort to investigate the importance of groundwater flux, water and steam extraction rates, steam injection well spacing and steam injection rates for the temperatures that can be achieved in situ.*

As stated in the RD/RAWP, Appendix D, p 63:

> *Hydraulic control will be verified by ensuring net water removal from the Site and groundwater elevation monitoring outside the TTZs. Liquid removal rates will be set to ensure that liquid extraction is at least 1.5 times the net water injection rate via steam to ensure hydraulic containment of the TTZ.*

As stated in the RD/RAWP, Appendix E, p 5-14:

> *Regardless of the level of model sophistication, geological complexity adds a high degree of uncertainty to any prediction that is based on assumed geologic interpretations.*

As stated, calculations should be accompanied by an energy balance and include the impact of groundwater flow into the site from natural gradients. What are the current estimates for groundwater fluxes into the individual treatment zones? Please provide the hydraulic containment calculations performed with the lesser mass ratio of 1.5 that includes the natural groundwater gradient and an energy balance.

2. Perimeter Monitoring

As described below, perimeter monitoring data do not lead to a conclusion supporting hydraulic containment..

2a. Perimeter Groundwater Elevation Measurements

The interpretation of groundwater elevation measurements at ST012 during steam injection is very complex. The impact of a growing steam zone, heterogeneous soil layering, and a rising water table on water level readings is not easily assessed. The pressure gradient in a steam zone is different than the pressure gradient in water saturated soil such that some knowledge of the growing steam zone location and volume is desirable. In addition, significant flow through a high permeability interval such as found in the deep LSZ below approximately 230 feet bgs may occur without a measurable change in water level. This interpretation is further confounded by unknown leakage through the overlying low permeability zone and the rising water table. For these reasons, the water level measurements are considered an unreliable indicator of hydraulic containment during steam injection. This is supported by the significant

fluctuations in perimeter water levels reported on Figure 22 of the weekly SEE system progress reports.

2b. Perimeter Temperature Measurements

Perimeter temperatures are increasing, suggesting a loss of hydraulic containment rather than maintenance and temperature monitoring beyond the boundaries is not available. Examples are provided below.

i). As reported in the Weekly Progress Report from 30 March 2015, temperature arrays were pulled from TMP-7 and TMP-17 and found to be damaged. The timing and nature of the damage was not reported and the previous readings appeared to be functional and reasonable. Hence, at a minimum the data indicated heating at those locations (i.e., reasonable temperature responses) and do not support hydraulic containment. Damage to the temperature arrays would not be expected to yield temperatures deviating from ambient in such a reasonable manner.

ii). TMP-7 is located between two extraction wells on the eastern boundary of the TTZ and shows an increasing temperature in the deep LSZ. This deep interval is associated with the higher permeability soils cited above and the increasing temperature indicates the flow of hot water away from the TTZ and argues against hydraulic containment.

iii). TMP-17 is well outside the UWBZ treatment area yet it has a large temperature response at 190 ft bgs that is not vertically continuous with temperature readings in the LSZ that suggest steam conditions on the boundary of the LSZ. These observations do not support a finding of hydraulic containment.

iv). Temperature monitoring does not exist at the boundary or beyond at the southwest corner of the LSZ TTZ and therefore no assessment is available from temperature readings for hydraulic containment in this area of the site.

v). Temperature monitoring does not exist at the boundary or beyond on the western boundary of the LSZ TTZ and therefore no assessment is available from temperature readings for hydraulic containment in this area of the site. TMP-3 has shown heating in the UWBZ outside its TTZ boundary.

vi). Temperature monitoring does not exist along the full length of the northern boundaries of either the LSZ or UWBZ TTZs and therefore no assessment is available from temperature readings for hydraulic containment in these areas of the site.

2c. Perimeter LNAPL Measurements

i). In the 9 March 2015 response to ADEQ's comments, the Air Force stated:

> *The observed increases in LNAPL in this well [i.e., ST012-W37] during SEE operations are in response to hydraulic changes in the area that allow LNAPL already in the vicinity to accumulate in the well,*

similar to observations during the operation of the ST012 containment system before SEE operations commenced. We have also seen similar responses in ST012-W11 recently at a smaller scale.

What level of LNAPL accumulation in W37 or W11 would indicate loss of hydraulic containment? If the value cannot be quantified, then this parameter is not applicable to evaluating hydraulic containment.

ii). In the March 9, 2015 response letter, AF states that LNAPL is migrating "locally within the containment area" based on measured gradients. However, the table embedded within slide 4 of the letter indicates periods when the differential between wells W37 and W24 is either negative or positive, suggesting either an inward or outward gradient.

Following the initial LNAPL increase in well W37 in late December, the LNAPL was removed by bailing and then pumping. LNAPL has continued to move into this well in significant quantities, suggesting that the volume of LNAPL in the area is greater than anticipated. Based on the fluctuating perimeter water levels and the noted changes in the groundwater gradient, the LNAPL boundary near well W37 cannot be known with any certainty.

The AF should provide additional data to verify the extent of LNAPL contamination, or provide a plan to confirm the extent of the LNAPL boundary east of Sossaman Rd.

2d). Perimeter Dissolved Benzene Concentrations

Dissolved benzene concentrations have definitively increased in five of the eight LSZ perimeter monitoring wells and dramatic increases have been observed in W11, W34, W36, and W37. Of the parameters measured in the perimeter monitoring wells, the benzene concentration is considered the most reliable indicator of hydraulic containment. Increasing concentrations are indicative of a loss of hydraulic containment.

The most recently available analytical data from March 2015 shows benzene at 470 µg/L in well W34 and 1,000 µg/L in well W36. Both of these wells are a significant distance down gradient of the ST012 source area and thermal treatment zones, and the reported COC concentration increases coincide with startup and operation of the SEE.

As a result, additional wells are necessary to determine the full down gradient extent of COC concentrations exceeding ROD cleanup levels.

Specific Comments On Weekly Progress Reports:

1. Energy Balance for Individual Treatment Zones

The water extraction and steam injection are provided for the three individual treatment zones. To aid in assessing progress at the site, please similarly provide separate energy balances and energy

balance rates for each of the three zones treated by SEE (i.e., energy injected, energy extracted and energy in the soil).

2. Steam Zone Volume for Individual Treatment Zones

In addition to an energy balance for each zone, please provide an additional graph with an estimate for the steam zone volume in each of the three treatment zones. This plot could also be a logical extension of the Average Temperature presented for each zone.

Thanks.

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